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THE CARNEGIE INSTITUTION.

BY PROFESSOR SIMON NEWCOMB.

IT is now nearly two years since the world of science heard with lively interest the announcement of the most munificent individual gift ever made for the promotion of knowledge. Up to that time the Smithsonian Institution was the most richly endowed establishment which, not being devoted to the special purposes of a teaching institution, or the conduct of a prescribed line of research, was free to use its funds in the promotion of knowledge in any direction that might be most promising. Now, the Smithsonian endowment, with all the additions made to it during the sixty years of its existence, was multiplied tenfold at a stroke. Any misgivings that might have been felt as to the wise administration of so important and novel a trust were quieted by its having been placed in the hands of a body of men of national reputation, whose standing before the public would afford the best guarantee of wise management. Believing that such a body could form a better judgment as to how the Institution could attain its object than could any one individual, even he himself, the founder left free the hands of his managers, prescribing only certain general conditions defining the aims to be kept in view, and outlining the field of activity. The guardians of the trust lost no time in beginning preparations for its execution. At a preliminary meeting the necessary steps were taken for putting into operation the executive machinery necessary to a survey of the field and a decision as to what the Institution could most advantageously undertake.

The terms of the trust were so broad that it would not be surprising if the first sentiment of the organizing body were one of doubt, not to say perplexity, as to the direction which its activity should take. The possible field of its operations was almost unlimited; and, at the same time, there was no precedent by which it could be guided, unless that supplied by the Smithsonian Institution. But the world has advanced so far during the sixty years that this institution has existed that its experience could not well form the basis of work on a scale so much larger. Of the numerous questions which were asked as to the policy of the Institution, none could be answered in an authoritative way. Were its operations to be confined to our own country, or would they extend around the world? Would a permanent body of scientific investigators be organized, or would the Institution look to individual agents who should execute its functions? If so, would these agents be the existing institutions, or would they be individuals? All such questions as these were left open by the founder, and his trustees did wisely in deciding none of them in such a way as to limit their operations.

Another question was, whether the managers of the Institution would welcome a public discussion of its policy. We are not aware that this question was ever formally put; but an affirmative answer would seem eminently proper. In the case of an institution, publicly organized for the promotion of knowledge, and not to serve any private purpose of its managers, it would seem wise to encourage the widest discussion of its policy, and the most searching criticism of its proceedings. An animated discussion in the pages of "Science" was the result of this view. One feature of the discussion might have been foreseen. The suggestions were so numerous and varied that it was impossible to combine even their main features into anything like a homogeneous whole. Material for thought was undoubtedly afforded in sufficient quantity, but the only way in which it could be utilized was to extract here and there a little of the essence, to be utilized as far as possible, and then, casting aside the rude and indigestible remainder, to survey the field for one's self, in order to decide upon a course of action.

The first formal step was to appoint in each of the great departments of science an advisory committee charged to report in what way the needs in its field could be most effectually supplied. The reports thus elicited are found in the first issue of the Year Book of the Carnegie Institution. They are not only worthy of study as valuable contributions to an appreciation of the several subjects treated, but they may be of interest in other lines of thought than those formally discussed. After receiving and digesting the reports, the active work of the Institution was initiated at a second meeting of the Board of Trustees, held in November, 1902. The year's work started after this meeting is briefly summarized in the second issue of the Year Book, which has just been published. These two publications will be taken as a basis for discussing the adopted policy.

The prescriptions of the founder will be seen to leave open to the Institution two closely associated but radically distinct lines of activity. One looks to the Institution itself becoming an active agent in the promotion of knowledge, founding its own establishment and doing its own work. This would not preclude its promoting the work of others, but it would make such action conditional on the work falling into some general scheme. The main feature of the other policy is that the works to be aided should be those of others, and that the selection should be determined upon the individual merits of each, as inferred from the representation made by its advocates. Both of these lines of policy are indicated in the conditions of the trust; the first, perhaps, rather by implication and inference than by direct statements; the other by express provision. The words which indicate the first plan are: "To promote original research, paying great attention thereto as one of the most important of all departments." It might be claimed that there is an essential difference between "promoting" research and conducting research, and that, had it been expected that the Institution would be an active agent in carrying on researches, a different word would have been used. On the other hand, "paying great attention" to research implies a more active function than this.

Another charge is that of discovering "the exceptional man in every department of study whenever and wherever found, inside or outside of schools, and enabling him to make the work for which he seems specially designed his life-work." This, again, implies an active agency in searching out men, and not merely a sitting in one's office to receive and consider applications. The execution of this clause is, perhaps, the most difficult of all, because it so often happens that the supposed exceptional man turns out to be, after all, very commonplace. Once or twice in a generation a man like George William Hill appears on the scene, whose first work stamps him as among those who are going to succeed. But, even in a case like this, only an expert is able to judge the man and his work. And yet, after all, any one who reflects on the large part played by the individual in scientific progress cannot but admit, that the discovery of the exceptional man may well be regarded as one of the most important functions of the Institution.

Another implication in the same direction is the condition, that the Institution should be founded in the city of Washington. This may be fulfilled in letter, but hardly in spirit, by a mere holding of meetings and transaction of business in Washington. There can be no sound reason for this condition, unless the founder, sympathizing in the general feeling of pride in our national capital, desired to add the intellectual feature to the great volume of attractive works with which our nation is embellishing it. Such an end cannot be attained unless some other work than that of a purely business and administrative character is conducted in Washington.

Comparing these two policies with the actual operations of the Institution, so far as developed and planned for the coming year, it is very clear that the second policy has been followed to the exclusion, in spirit at least, of the first. So far as has yet become apparent, the main functions of the Institution have been to carefully collate and study all the applications for assistance which have been made to it by individual investigators, and to comply with such of them as seemed most worthy and important.

One who is neither in the councils of the Institution, nor in any way a sharer of its responsibilities, must be cautious in assuming too certain a knowledge of its policy. Yet the impression created by a study of its widely extended operations is, that unity of purpose has not been considered important. In the absence of any reason to the contrary, it is admissible to assume that the future will be like the past. The ship has been launched, and, although she has scarcely more than left her moorings, we may infer whither her course, if unchanged, will lead her. Material for such an inference would seem to be afforded by the reports of what has been done during the past year. If variety in character and geographic extension are desirable features, they are certainly not wanting. The grants made for investigations in various branches of science number sixty-six. On the other hand, it is significant that about one thousand grants, asking for a sum total of some three million dollars, have been refused or indefinitely postponed.

A few examples of the grants actually made will suffice to give a general idea of their character. Among the sciences, that which has received the most liberal support is astronomy, for the promotion of which twenty-six thousand dollars was allotted. The work promoted was that of the Harvard, Albany, Lick and Yerkes Observatories, as well as of individual astronomers. In geographic extent, the researches extend from the trans-Caspian region in the east, where a geological and archæological inquiry has been instituted, to Arizona in the west, where a desert botanical laboratory has been established to investigate the adaptation of plant life to arid conditions. Medical men throughout the world will be much interested by the reestablishment of the "*Index Medicus,*" in which the literature of their science is catalogued. Individuals or committees have been appointed to inquire into current investigations of nutrition and other problems of physiology, and the establishment of proposed observatories and laboratories. A bureau of American history has been established in Washington. It is proposed to make a comparison between the geological features in eastern Asia and western America. On the humanistic side, a study of the economic conditions of the United States has been promoted. A hand-book of the learned societies of the world is nearly completed. A botanist, working at the Royal Botanical Gardens, Berlin, is engaged in an investigation of the Philippine flora.

At the Johns Hopkins University, investigations in physical chemistry and osmotic pressure, as well as other subjects, are being carried on. A practical character is given to work by experiments on ship resistance and propulsion, as well as by investigations of aluminum bronzes. The Marine Biological Laboratory at Woods Holl has received an allowance for the maintenance of twenty tables, and the Biological Station at Naples, Italy, an allowance for two tables.

That these and the twoscore other works promoted are most worthy of the support accorded them, is unquestioned. If any mistakes have been made, it is only because a minute inquiry into each of a thousand applications was beyond the power of so small a body of men. And yet the question is well worthy of consideration, whether a plan of work more comprehensive than, on the face of it, these grants seem to indicate, would not have been advisable, and would not have rendered the Institution a more important factor in the world's progress. That the adopted policy will lead to a measurable extension of scientific research on its present plane is undeniable; but will it elevate the plane? We have already pointed out that two lines of activity were open, the one looking to the Institution becoming itself an active factor in progress, in which case its main object should be to elevate the plane of work in all departments, and the other to being simply a promoter of works on the existing plane.

To make our meaning quite clear, we may consider some of the works just enumerated. There is, perhaps, no social problem to-day in which the interests of human society are more deeply involved than that of an understanding of the causes which affect the welfare of the masses. Why is it that we find the laboring classes in Germany better fed and housed than those of Russia and Austria, those in England yet higher in the scale, while in America they are more opulent than in any country in Europe? It cannot be mere want of land, for there would seem to be more unoccupied land in Russia than in most other European countries. An investigation into the causes of these conditions is of the utmost importance, because, when any system of public policy affecting industry is under consideration, the first question should be, Will the effect of this system be to depress or to elevate the masses? This question it is impossible to answer until we have a well-established science of public and individual prosperity, grounded on correct economic principles, and on a comprehensive study of facts. That such a science is possible cannot be doubted, because all the elements which affect that prosperity are completely within the range of our knowledge. The two elements on which the whole fabric depends are, rate of wages and cost of subsistence. The real difficulty is that the tracing of these two elements in the ramifications of industry is a complex mathematical process, for which, up to the present time, not even a nomenclature has been invented. The problem will, therefore, not be solved until it is taken up by mathematicians, who will find it so different in form from those with which they are conversant that they must devote much thought to the subject before even the method of investigating it can be discovered.

Whether this end was in view in that study of the economic conditions of the United States which the Institution has promoted, it is impossible to say; but the fact that the only end mentioned in the report is a history of progress must lead us to infer a negative. The foundation of such a science as we have suggested will never be laid by a mere promotion of the works of individuals or institutions, and that for the reason that no individual or institution combines the incentive to the work with the human machinery necessary to its prosecution. The institution that shall undertake the work will elevate social study to a higher plane than it has ever yet reached. But nothing less than an institution can be expected to carry on the work.

We might consider almost all the grants which have been promoted from the same point of view. In nearly all cases we can only imagine an end which the grantees may have had in view. Even in doing this, we cannot evade the conviction that a greater amount of co-ordination should have been secured in the work than seems to have entered into the plan.

On the two lines of policy which we have indicated the world at large always has been and always will be divided. The one may be defined as the policy of individualism, the other as that of collectivism. The affairs of men can never be administered on either of these systems, to the exclusion of the other; and the question whether the Carnegie Institution is making the best use of its resources by continuing on its present line of exclusive individualism is worthy of serious consideration. This question can best be considered if the writer, ignoring the existence of the Institution, simply sketches out what seems to him the ideal mode of procedure, should an institution be established in the city of Washington for carrying on scientific researches on a large scale, and at the same time promoting the intellectual development of the country.

In this case, the first question to be considered is not, What assistance do the scientific investigators in the country need in carrying on their work? but rather, What are the needs of science at the present time? This difference may seem a small one; but, small as it is, it is the pivot on which the whole policy of the institution must turn. If the collective policy had been adopted, a consultation with the best authorities, acting either as individuals, or as committees, would, of course, have been the first step. But a well understood condition would be that, while an adviser thus called in was not prohibited from making known either the wants of his special work, or his own desires as to what he should undertake, such wants and desires should be assigned a subsidiary place. The knowledge which is sought is not that relating to work now in hand, but to the work which will be wanted by the future, and which can be initiated by an institution having very large means at its command. We want to know what the future can be made, if progress is aided by a munificent endowment. In a word, the work is not to be started on the present plane, but on a plane a stage higher than the resources of the past admitted of its reaching.

Some features of the situation which would have been brought to light by such an inquiry may be pointed out. A comprehensive survey of the material now available for the promotion of science would have shown, that the nineteenth century has been industriously engaged in amassing observations of the phenomena of Nature in all her departments, the main results of which are still to be extracted. Meteorological observations have been and are being accumulated in such numbers that the more advanced thinkers on the subject are calling a halt. So far as they can see, no more valuable result can be derived from the continuation of the series than from the series as it now exists. But there is no sign of response in any quarter. Magnetic observatories at various points on the globe are recording the changes in the magnetism of the earth. Systematic observations of the spots on the sun have been going on for more than a century, especially at the Greenwich Observatory during the past twenty years. The great observatories of the world publish annually, or from time to time, stately volumes filled with observations on the positions and aspects of the great bodies of the universe. Spectroscopists are measuring the motions of stars, and making such records of their light as may lead to a knowledge of their physical constitution. Observations of the aurora are made and published at many points in Europe and America. On the humanistic side we have statistics relating to almost every interest of the human race, awaiting the hand of the investigator who shall derive results from them.

It goes without saying that this mass of material is, in its original state, of no importance to humanity. It becomes important only through the results that may be derived from it.

We must, therefore, inquire how these results are obtained and to what extent they are being worked up. Continuing the inquiry in this direction, we shall find an illogical disproportion between the amount of effort devoted to the accumulation of observations, and that devoted to deriving results from them. Men are founding new observatories or stations for observations all the time, but no one has yet thought of founding an institution for deriving the best results from the observations already made. It is quite exceptional that an institution engaged in making meteorological observations makes any comprehensive investigation in climatology, even that of their own region. For the most part, this branch of the work is left in the hands of individuals. Examining what the latter have done, one cannot fail to be struck by the piecemeal character of their work. This is necessarily the result of individual effort, because the proper handling of the whole mass is beyond the power of an individual. It can only be done by an organization.

Inquiring into the wants of such an organization, we should find one most vital in its character, and yet apt to be overlooked. There is a science which develops the methods of deriving results from great masses of observations, and of reaching an exact judgment as to their reliability. But this science is untaught in our universities, unless occasionally in the most abstract and general way. An examination of what individuals have done would show that, for the most part, they were little acquainted with the practical applications of this science. And yet, a clear understanding of its methods is essential to the extraction of the best results. Without this requirement, it would be useless to do anything on a large scale. Happily, knowledge on the part of a very few individuals will speedily leaven the whole mass when there is occasion for it. The one necessary condition of success in attacking the work would have been to learn what men in any part of the world were best acquainted with the scientific methods required, and to call in their advice in such a way as it could be most effectively rendered. With this aid an institution, which it might fairly be expected would prove one of the most important of the twentieth century, could be set going; and it can be set going in no other way than one which starts with the problem: What does science require, and how can these requirements be fulfilled?

The foregoing suggestions apply only to observational science.

But the result would not have been materially different on entering the field of experiment. The writer is confident that, had three or four of the leaders of experimental science at the present time, in various countries, been called in to survey their future field, they would have agreed that the study of the mysterious radiations from material bodies, which commenced only ten years ago with the X-rays, and which has since astounded the scientific world by the revolutionary character of the phenomena it has brought to light,—the outcome of which no man can see,—was a field of work in which the co-operation of a body of men, which could be secured only through a single great institution, offered results of the greatest promise. No one knows to what results even so simple a study might lead as that of the radio-activity of bodies — that singular property by which various substances, which we cannot yet catalogue, under circumstances which we are not yet able to accurately define, send off an invisible emanation, having among other properties that of making air a conductor of electricity. When the laws of this activity are brought to light, who knows how important the conclusions to which it may lead? A possible revolution is already foreshadowed in the behavior of radium, that mysterious substance which sets at naught what we supposed to be one of the best established laws of modern physics, by persistently radiating energy at the lowest temperature that science can produce; a temperature at which, according to all preceding theory, activity of every sort should cease, and every object should become a dead mass. Had such a result been predicted to a physical philosopher five years ago, he would have replied, "That is absurd. If you ever find any such substance it will be after you have been able to run a steamship by the heat of the ocean itself." Now such a substance has been found; who knows what may follow?

The carrying out of such a system of investigation as is here mapped out requires an organization—a co-operating body of men collected in a single spot, profiting by their mutual advice and experience, and clarifying each other's ideas by discussion of the obscure and difficult points arising at every step. The end aimed at is so different from that of any existing institution of learning that no association with such an institution is necessary. The best place for the institution is the city of Washington. In order to reach the highest state of efficiency, it would become, to a greater or less extent, a teaching agency; but it would not compete with any existing institution of learning, because its teaching would be of a more specialized and advanced character. It would simply supplement the work of our universities and colleges. The Doctor of Philosophy emerging from one of these institutions, has plenty of theoretical knowledge and practical training in the direction of whatever science he has been studying at his university, but he has no training in the special work of the institution whose functions we have been outlining. Why is the twentieth century advancing without our nation enjoying the great advantage of having, at its capital, the atmosphere which such an institution would diffuse through its life?

The answer is not far to seek. The influences against such an outcome have been strong enough to paralyze all efforts to promote it. Some of the reasons which have been brought forward against such an organization as that here suggested, should be considered. The most plausible is that the men now engaged in carrying on the world's work in science and in education, though scattered in various places in this and other countries, already have at their command such facilities as are afforded by their respective institutions. All that is necessary is to discover what each one is doing, and whether he stands in need of additional facilities. If he does, supply them. As, in nearly all cases, he already has a part of the facilities necessary, the latter will thus be utilized to the greatest possible extent, and he can do his work where he is better than anywhere else.

This argument is excellent as far as it goes, but it leaves out of sight two most important points decisive of the question. It presupposes that the work most worthy of encouragement is that which men are either doing at the present time, or, individually, wish to undertake. Now, this will never be the case until the field of scientific investigation has reached its ultimate limit. An institution with vast facilities should devote itself to looking forward to what ought to be and can be done in science, rather than to the matters in which men are momentarily interested. Here, as in industry, plant, methods and ideas are constantly becoming antiquated, and real progress involves their constant renewal. An institution which ignores this may do much good work, but will never mark an epoch in the development of science.

Another weak point of the argument is that it leaves out of sight the most efficient agent of progress in every field of human activity, that of association and mutual attrition between man and man. Perhaps there is no condition of progress the necessity of which admits of being better shown by actual experience, little though it may be recognized. The more profound the region of thought, the more necessary that he who enters it shall be stirred by suggestion, even from his inferiors in command of his subject. Two men working in company will not only do twice as much as two working individually, but it may be expected that one of them will do things which, had he been alone, he would never have been capable of doing. If, as is always the case, he encounters at every step a serious difficulty, a mere suggestion from another may set his thoughts in the direction required for its removal. If, eighteen hundred years ago, Hipparchus, Aristarchus and Ptolemy had lived at the same time, and could have been brought together to discuss day by day the mystery of the celestial motions, I believe that the true system of the universe would have been brought to light fourteen centuries before the time of Copernicus. May not the same be true of the mysteries which modern science has opened up to us?

Another objection to the policy here advocated is based upon a widely diffused fear of centralization of learning, especially at the national capital. But the attrition which we have just shown to be necessary is impossible without centralization. If the arguments in question were well founded, it would be better if the resources of such an institution as Harvard could be divided between a number of small institutions scattered over the State or the country. Granting that it were possible that the work of the university could be done by having one professor in each town of the State, would the separation be an advantage? There can be but one answer to this question. The activity of the teachers would gradually come to an end, and the university itself would cease to be a factor in intellectual progress.

Another fear is that, if we allow any institution whatever to grow up with the advantages afforded at that point, Washington may become a sort of Paris, and will become so influential that, outside of it, a scholar will be outshone by his fellows at the capital, even as the professors at the provincial universities of France are outshone by the members of the Institute. The scientific work of the capital would, however, be so different from that done elsewhere that this result seems hardly likely; if, however, it should occur, would it really be an evil? The smaller universities of our country are none the worse because Yale, Harvard and Columbia outshine them, and neither Yale nor the country at large suffers because Harvard has richer means and a wider field of activity than any other of our universities. Why, then, should any investigator or any section of the country be the worse for the growth of an institution of research in Washington, which may, at some future time, become the most important of the land?

It is worth pointing out that the almost inevitable outcome of the present policy will be a centralization of a very objectionable kind. If the activities of the Carnegie Institution were to be wholly confined to aiding individuals here and there, that end could have been best attained by dividing the endowment among the leading institutions of learning, under such restrictions as might have been necessary. Every such organization could then have determined for itself, better than a central one at Washington, what the needs of its professors were, and what might be the importance of their work. It could have established branch stations at least as well as can the Washington institution. It could have sought out the exceptional man with even better chances of finding him, because its field of knowledge would have been wider than that of any central authority. Each could, for itself, have selected the best research-assistant to be found.

Now, instead of this result, we actually have a central authority passing judgment upon the relative importance of the work being done at all the institutions of learning from which applications may come, and aiding them, or refusing aid, according to their judgment. One very probable outcome of this has not been sufficiently considered. It must tend, to a greater or less extent, to diminish the spirit of individual effort, just as gifts are apt to do in many other walks of life. This effect will be intensified by a very obvious and reasonable provision announced by the Institution as governing its action. It does not propose to undertake anything that is being well done by other agencies. It would, of course, be superfluous to assist a professor in cases where the patrons of his own institution could be induced to do so. The latter will naturally not be very liberal in giving their funds if the Carnegie Institution can be successfully appealed to. If the appeal is a failure, that failure will be a reason against the project in the mind of a possible donor. The dilemma will be that of Omar:—If the Carnegie Institution can be induced to support your work, our aid is not needed; if it cannot be so induced, the object is not worthy of our support. Of course, it is not claimed that this consideration will be universal, or will be operative immediately and in all cases. But to suppose that it will never be operative in any degree is contrary to every principle of human nature.

The progress of knowledge has brought us to a point where our nation needs the services of a body of men who shall be engaged in work of a distinctively different type from that carried on in our traditional institutions of learning, a work which belongs peculiarly to the present and future, because it was not possible in the past. Looking at our intellectual history, we have grown from the high school of our revolutionary ancestors to the college; from the college stage we have grown to the university stage. Now we have grown to a point where we need something beyond the university. We want an institution at the city of Washington at which shall be organized a system of research on that higher plane and larger scale which the progress of experimental science and observational knowledge now requires. Such a work would be at a disadvantage in being connected with any existing university for the same reason that the college was at a disadvantage when grafted on the preparatory school, and for the same reason that our universities are now at a disadvantage in being grafted upon the colleges. What we want might be appropriately called the National Research University. If the Carnegie Institution is not to grow into anything of this kind, is there not among us some possessor of great wealth ready to become its founder?

SIMON NEWCOMB.